THE RECORD

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. 2. **1877.** **No. 7.**

U. S. NAVAL ACADEMY, ANNAPOLIS,

JANUARY 11, 1877.

Lieut. DUNCAN KENNEDY, U. S. N., in the Chair.

THE 100 TON GUN.

BY LIEUT. THEO. B. M. MASON, U. S. N.

The gun designed by Capt. Noble was built at the works of Sir William Armstrong, known as the Elswick Ordnance Works, New-Castle on Tyne, England.

The contract called for a gun to throw a 2,000 lb. projectile, with a muzzle velocity of at least 1,350 ft. per second. The proof, before acceptance, was to be 50 rounds fired with service charges, 5 of these rounds to be with projectiles weighing 2,500 lbs. the others with the service projectile. This gun is intended to form one eighth of the armament of the turreted ironclads *Duillio* and *Dandolo*, now in course of construction. It has been nick-named the "King Gun," by the Italians. Over two years were required to put this gun in existence. When completed it was taken to Spezzia, in a vessel arranged for its accommodation. At Spezzia, it was mounted on its carriage which for the time being had been placed on a large pontoon specially constructed for the purpose. On the 20th of October, 1876, everything was prepared for the trial.

The gun is constructed on the well known Armstrong principle, with the exception of the substitution of coiled for forged iron in the inner breech coil or tube. Some of its dimensions are:

Total length,	32′ 10″.5
Length of bore,	30′ 6″
" " steel tube,	31′ 3″
Greatest diameter,	6′ 5″

Diameter at trunnion coil,	5′ 5″.5
" " muzzle,	2′ 5″
" of bore at present,	17″
" " chamber "	17″
Breech preponderance,	4 tons.
Rifling,	27 grooves.
Twist increasing from 1 turn in	150 calibers.
to 1 " "	45 "

The A, or interior tube is of steel, made in two parts varying in thickness from the rear where it is 6″ to the muzzle where it is 3″.5. The thickness of the end is 9″.

Over this A tube are ten coils of wrought iron bars, six of which refer to the breech and four to the muzzle.

For a distance of 13′ from the rear end of the gun, the steel tube is enveloped by a breech coil 7″ thick. This overlaps the rear of the A tube, and receives the cascable piece, which is of forged iron, 1′ 7″.5 thick being held in place by a screw thread. Through the axis of this cascable piece is the vent, and at the right side of it is the safety gas escape.

Over this first coil is a second one 9′ 6″ long and 8″ thick. The trunnion coil is next with a thickness of 11″ and a length of 2′.

Over the second or B coil is a third one 5′ 6″ in length, and 9″ thick forward of which and reaching to the trunnions is another 6″.5 thick. From the trunnions to the muzzle are five coils tapering down to 2″.5.

By this arrangement we have 30″ around the powder chamber and seat of the projectile and 2′ 4″.5 to the rear of the charge. The coils are so arranged that they interlock and overlap each other slightly, at the junctions. Around the C. coil and let into it are two strong wrought iron bands which connect the gun, by means of a key, to the sliding block of the elevating apparatus.

The carriage on which the gun is mounted, and which is constructed without any reference to being worked by hand, was designed by Mr. G. Rendel, the experienced engineer of the Elswick works. All motion is received, given and controlled by hydraulic power. It is at present placed, as heretofore stated, on a specially constructed pontoon. The idea of the pontoon is to put the gun afloat, and to give it the training facilities that it would have in its turret. The trunnions are mounted on heavy blocks of wood, which slide on the carriage proper. To each trunnion is attached the piston of a strong hydraulic cylinder, which is secured at the rear of the carriage so as to be one on each

side of the breech. These two cylinders take up the horizontal component of the recoil, which, except at great elevations, is by far the greatest. They also serve to run the gun out. By means of valves attached to the cylinders the recoil pressure is regulated and the gun checked in running out. Under the breech and joined to it by the key, previously mentioned, is the sliding block of the elevating apparatus. This block slides on a lever plate, which is pivoted horizontally at the rear of the carriage. This pivot is so placed that the gun will come level at the end of the recoil. Under the lever plate, and attached to it by a horizontal pivot bolt, is the piston of another hydraulic cylinder, which serves to elevate or depress the gun, also to take up part of the vertical component of the recoil. At small elevations it is assisted by the trunnions and at great ones by a rubber buffer which receives the end of the lever.

For sponging and loading, the gun is run in and depressed so that the muzzle points into an armored hood. The sponging is done by a telescopic handled sponge to which motion is given by hydraulic power; a spring valve in the side of the head of the sponge is pressed upon by the bottom of the bore, when it reaches that part, and a stream of water ejected which assists the sponging.* The gun being sponged, the cartridge and projectile are brought on the lower deck, under the muzzle, on a truck; this truck is elevated to the muzzle on a hydraulic lift; the checking apparatus, which checks it when the cartridge is in a line with the bore, acts automatically. The sponge, now become a rammer, pushes the charge and projectile home together. The projectile is of the Palliser nature similar to those used in the heavier English guns. The studs which strain the gun and weaken the projectile having been omitted and an expanding copper base ring substituted. This ring acts as a gas check and also communicates the rifled motion to the projectile. In order to insure perfect accuracy of fit and to render more easy the loading, the ring is scored to correspond with the lands. The ogival head is struck with a radius of 1¾ diameters instead of 1½ as usual, making it a little more pointed. The service charge which is at present 341.6 lbs. of English mammoth powder 1″.5 cubes, made at Waltham Abbey, or 400 lbs. of Fossano Progressive Powder.

The cartridge is pierced from the rear in the direction of its major axis, and connecting with the vent, by a light copper tube. This tube

* This is an American invention first proposed by E. A. Stevens, Esq., of Hoboken and designed by Alex. L. Holley, B. P. C. E.

extends to the middle of the mass, the idea being to insure that point's being the first to be ignited. The exterior of the cartridge is banded to give it compactness.

The trials of the gun took place against five targets made to represent what might be the armor of the *Duillio* and *Dandolo*, the idea being not only to test the gun but also to determine the best style of armor to oppose it, and the best way to attach that armor to the ship's side. We will designate the targets by numbers.

No. 1 was constructed of two plates one above the other, both of rolled iron and both 11′ 6″ long, 4′ 7″ deep and 22″ thick, both bolted through and through. The backing consists of two thicknesses of timbers, the front ones laid horizontally, the rear ones vertically, together giving a thickness of 29.″ Behind the backing is the skin consisting of two ¾ in. plates of wrought iron—the whole supported by irons representing the ribs of the ship, the deck beams being bent down to the ground and well strutted out. The upper plate was made by Cammel, the lower one by Marrel.

No. 2 on the same frame as **No. 1**, consists of two soft steel plates made by Schneider at the Creuzot works in France. The upper one 11′ 6″ by 4′ 7″, the lower one 10′ 9″ by 4′ 7″ both 22″ thick; backing &c., same as **No. 1.** Bolts screwed into the rear of the plates and penetrating only part way.

No. 3, called sandwich, on account of its construction. Upper part 12″ wrought iron plate by Marrel, 11′ 6″ by 4′ 7″, next horizontal wood backing, next 10″ Marrel plate backed by vertical balks, skin &c., same as **Nos. 1** and **2.**

Lower part, face plate 8″ wrought iron backed by vertical timbers, next a Gregorian cast iron plate 14″ thick, next vertical balks; skin &c., same as others.

No. 4 on the same frame as **No. 3.**

Upper part. 12″ wrought iron plate by Cammel 11′ 6″ by 4′ 7″, next horizontal wood backing, next 10″ Cammel plate, backing and same as upper part of **No. 3.**

Lower part. Face plate 8″ wrought iron, immediately in rear 14″ Gregorian cast iron plate, backing &c., same as **No. 1.**

No. 5. Erected after the destruction of **Nos. 1** and **2,** consisted of two Brown 22″ wrought iron plates of the same dimensions and with the same backing as **No. 1.**

The horizontal balks were further secured in all the targets by wrought iron L irons fastened to the vertical balks.

The sum of all the wood backing in each target was 29″.

The Gregorian cast iron mentioned is worthy of notice. It is made near Lake Como and is used, in the construction of ordnance, by the government at the Royal Arsenal in Turin. The guns, there manufactured, have always been noted for their excellence, far exceeding any other European wrought iron ones, and nearly equalling our own hollow cast Dahlgrens. It has a tensile strength of from 16 to 17 tons per square inch and is very hard.

The targets were placed in front of a bluff, on the left of the harbor, which had been excavated and the slope faced with fascines and gabions well shored up with heavy timbers.

The pontoon was anchored at 100 yds. from the targets so placed that the guns, by turning, could also be trained to seaward for long range firing. Screens for determining the velocity were erected on each of the ranges, one being also placed immediately behind the targets to ascertain remaining velocities after passing through.

A battery of two 10″ and one 11″ rifles was also erected on the shore. These three guns were tried against the different targets. It would be interesting to follow out the relative effects but our space will not permit us.

The gun was fired by electricity, first from a distance, but eventually from the deck of the pontoon close to the gun.

It is interesting to note in the different fires, the smallness of the pressures. These pressures are the *mean* not the *maximum* however. The great muzzle velocities, far in excess of what was contracted for, or what is needed to pierce any armor now in existence. The ease and smallness of the recoil, the smallness of the jar or concussion, (the oakum in the decks of the pontoon in front of the gun was not even started) all this seems to show that the gun has not been overworked, and that if the chamber were increased in diameter, much greater results might be obtained.* Heavy guns seem to work easier afloat than they do ashore, due probably to the fact that the vessel acts as a secondary slide, taking up much of the recoil and cushioning on the water.

The carriage and other machinery gave the greatest satisfaction. As to the targets, they were destroyed in every instance. The Schneider steel in its destruction stopping the projectile however, and the Brown plates giving wonderful proof of endurance. One thing is worthy of note; that is that the steel that stopped the 100 tons projectile

* This has just been tried with the 80 Ton gun.

was more deeply penetrated by the smaller gun's projectiles than the wrought iron plates which were thoroughly pierced by it. Cast iron even of the best quality seems to be utterly useless for armor purposes.

The pontoon was towed out and moored on the 20th of October, on which day the firing began and was continued with intermissions until Dec. 14th, when the 50th round was fired.

The accompanying table shows most of the items of interest developed by the different fires.

No. of Round.	Date 1876.	Charge weight and nature in lbs.	Projectile weight in lbs.	Velocity, feet per. sec.	Mean pressure in bore.	Stored up work.	Recoil valves set to lbs.	Recoil in inches.	REMARKS.
1	Oct. 20	200 W A 1½ in.	2000	not obs'd.	8.7	.....	1050	20	Taken to test carriage working.
2	" 21	300 "	2000	"	16.6	.....	....	36	Screens did not work, elev. 5°.
3	" "	300 "	2000	1375	15.9	.....	1150	34	" " " " 2°.
4	" 23	300 "	2000	.....	.....	.....	....	.....	" " " "
5	" "	300 "	2000	.....	16.0	.....	....	35.5	Chamber pressures very low, 5 tons per
6	" "	300 "	2000	1374	16.0	.....	....	37.5	sq. inch less than] elev. 1°48'.
7	" "	330 "	2000	1456	20.8	29.400	....	.....	80 ton gun,] " 1°.
8	" "	319 "	2000	1424	18.0	28.120	....	42.5	" 1°.
9	" 25	319 "	2000	.....	not obs'd	.....	....	44.75	" 6°5.
10	" "	336.6 "	2000	.....	19.4	.....	....	46.3	elev. 1°5.
11	" 26	319 "	2000	1437	.....	28.625	....	42.6	At earth faced with gabions.
12	" "	341 "	2000	1475	19.75	30.150	....	47.1	At Schneider Steel plate Upper No. 2.
13	" 27	341 "	2000	1478	19.75	30.300	...	46.0	At Cammel W. I. P. Upper, No. 1, Rem. Veloc. 650 ft.—5,500 T.
14	" "	341.6 "	2000	.....	.....	.....	....	.....	Shot broke up in bore.
15	" "	341.6 "	2000	1500	20.6	31.200	...	.....	At Marrels W. I. P. Lower No. 1.
16	" 28	341.6 "	2000	1493	20.1	30.920	....	48 2	At Schneider Steel plate Upper No. 2.
17	" "	341.6 "	.....	1492	19.2	30.880	....	46.0	At Marrels Sandwich Upper No. 3
18	Nov. 2	319 "	2000	.....	.....	.....	....	.....	At sand butt, Shot curved and came out at
19	" "	319 "	2000	1294	19.0	29.027	....	44.75	[top well to the rear.
20	" "	319 "	2000	1293	19.0	29.000	....	44.5	
21	" "	319 "	2000	1293	18.8	29.000	2000	44.25	
22	" "	319 "	2000	.....	.....	.....	....	42.5	
23	" 3	319 "	2000	.....	18.6	.....	....	40.5	
24	" "	276 Fossano.	2000	1165	.....	.....	1850	23.5	Progressive Powder (experimental).
25	" "	300 "	2000	863	10	.....	....	17.0	Powder could not have burned well.
26	" "	319 W A 1¼ in.	2000	.....	.....	.....	....	.....	
27	" 4	319 "	2000	.....	.....	.....	....	36.0	
28	" "	319 "	2000	.....	.....	.....	....	.....	
29	" "	319 "	2000	.....	.....	.....	....	35.25	
30	" "	.....	2000	.....	.....	.....	....	.....	
31	" "	.....	2000	.....	.....	.....	....	.....	
32	" "	.....	2000	.....	.....	.....	....	.....	
33	" 7	353 "	2000	1512	.....	31.700	....	42.5	Charges increased by permission of con-
34	" "	364 "	2000	1514	19.8	31.750	....	42.8	tractors, on condition that the increase
35	" "	375 "	2000	1542.8	21.4	33.000	....	.....	should be gradual.
36	" 8	319 "	2000	1348	.....	25.200	....	.....	
37	" "	341 Fossano.	2000	1415	.....	27.760	....	.....	Progressive powder, Considering small-
38	" "	363 "	2000	1408	.....	27.500	....	.....	ness of pressures velocities are good.
39	" "	363 "	2000	1444	13	28.900	....	.....	400 lbs. P. P.—341 lbs. W. A. P.
40	Dec. 13	.....	2000	.....	.....	.....	....	.....	Fired to determine charge necessary to
41	" "	.....	2000	.....	.....	.....	....	.....	give reduced velocities for plate tests.
42	" "	.....	2000	.....	.....	.....	....	.....	The gun having been accepted.
43	" 14	240 Fossano.	2000	1050	.....	.....	....	.....	At Cammel Sandwich Upper No. 4.
44	" "	240 "	2000	1050	.....	.....	....	.....	At Brown's 22" W. I. P.
45	" "	400 "	2000	1494	.....	.....	....	.....	At Lower Plate No. 3.
46	" "	400 "	2000	.....	.....	.....	....	.....	Shell broke up in gun.
47	" "	400 "	2000	1502	.....	.....	....	.....	At Lower Plate No. 4.
48	" "	240 "	2000	1062	.....	.....	....	.....	At Brown's 22" W. I. P.
49	" "	400 "	2000	1499	.....	.....	....	.....	" " "
50	" "	264 "	2000	1299	.....	.....	...	.....	" " "

No. 1 was fired after some delay, owing to bad weather, and the cartridge, which was very small, not igniting properly. This was to test the recoil apparatus only.

Nos. 2 and 3 were fired with service charges, but no velocities were taken as the screens were out of order.

Nos. 4, 5, 6, 7, 8, 9 and 10 were fired with charges up to 341.6 lbs., and gave excellent velocities with very small corresponding chamber pressures; less in proportion than the Krupp or Woolwich systems.

No. 11 was fired into the embankment, which might be supposed to represent an earthwork 27′ high, and 52′ thick; the shot buried itself so deeply that it could not be dug out on the day of firing. No. 12 was fired against the lower plate of target **No 2.** (Schneider steel) The plate was broken into fragments and fell in a pile at the foot of the target, except some small pieces left attached to the bolts, and some which were projected through the air in all directions. The backing was not pierced but the framing was dangerously bulged and torn.

No. 13 was fired against the upper plate of **No. 1** (Cammel's wrought iron). It pierced from front to back, coming out at the rear with a remaining velocity of 650′ per sec=5,500 foot tons of energy. The plate was destroyed and the backing broken up into splinters. The hole made would have caused the sinking of the vessel almost immediately.

No. 14. Shot broke up in the bore from some unknown cause. A man was sent in, on a peculiarly arranged rest, but could find no evidences of injury to the tube.

No. 15 was fired against the lower plate of **No. 1,** (Marrel's wrought iron) destroying the plate as in No. 13 which was to be expected, as this plate had already shown less resistance than Cammel's in the smaller gun trials.

No. 16 was fired against the upper plate of **No. 2,** (Schneider steel). This plate had already been struck and cracked by the smaller guns. The result was the same as in No. 12, although the projectile had a greater velocity and the plate had been injured.

No. 17 was fired against the upper plate of **No. 3,** (Marrel's sandwich wrought iron) same results as Nos. 13 and 15.

No. 18 was fired against the earth butt. The projectile described a curve and came out at the top well to the rear.

Nos. 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and 33 were fired for general results.

No. 33. At this round the weight of the charge was increased by permission of the contractors, who had the fullest faith in their weapon. They stipulated however, that the charges should be increased gradually. The charge was therefore 353 lbs. of W. A. powder.

Nos. 34 and 35 were fired for general results with increased charges. The air space was increased in 33 and 34 but remained constant in 35.

Up to this fire the gun had exceeded its stipulated capabilities, by 33 per cent.

No. 36 was for general results.

No. 37 and 38 were experimental with charges of a new style of powder, denominated "progressive," previously used in 24 and 25. It is manufactured by the Italian government at Fossano, in the following manner. Mealed powder is pressed into cakes which have a density of 1.79. These cakes are then broken up into irregular grains of from an eighth to a quarter of an inch in thickness. The grains are then mixed with a certain quantity of fine grain powder, and the whole mass is pressed into a cake which has a density of 1.776. This second cake is then broken up into tolerably regular pieces about 2″½ square, by 1″¾ thick. These grains if they can so be called, are therefore composed of a number of small pieces with a higher density placed like raisins in a plum pudding, in a sort of conglomerate powder material of a lower density. The intention of the inventors of this powder, was to bring about a condition of affairs in which more gas would be produced in a given time, when the powder had been partly burned than at the beginning of the ignition. The pressures were found to be abnormally low, and the velocities may therefore be considered as most satisfactory.

Nos. 40, 41 and 42 were fired to determine the charge of powder requisite for giving the 2,000 lb projectile, the reduced velocity with which it was determined to commence the renewed experiments against the plates. It was well known now that all the targets would be penetrated with a great surplus of power, if the gun were fired with the charges previously used. It was therefore necessary to reduce the charge to such a point as would render it possible to compare the relative resistance of the targets. The government had determined to accept the gun.

No. 43 was fired against the upper plate of **No. 4,** (Cammel's sandwich wrought iron.) The projectile passed through the first plate and cracked it from top to bottom, passed through the wooden interior, and entered the second plate 6″.8. The base of the shell broke up and the

remainder was starred. Judging from the past experiments with gun cotton shells the committee considered that had this shell been loaded, it would have blown off the front plate. The skin was cracked and the rib behind much bent. All this with an extremely small charge and a very low velocity.

The target previously referred to as **No. 5,** was now erected. The plates were rolled at the works of Sir John Brown & Co., in England.

No. 44. The sea being rough, the pontoon moved visibly after the gun was laid. The aim was at the lower part of **No. 5.** Owing to the motion, the projectile instead of striking the point aimed at, hit the plate on its lower edge, and broke into several pieces, which were deflected downward and made a hole in the ground about 8′ deep, in a slanting direction, under the target. Though lost, for the immediate object of the experiment, this round was of great interest, for it showed that a shell striking the edge of a narrow belt of armor, which will soon be all that ships can afford to carry, will tear through the bottom of the vessel with force enough to pierce engine-room and boilers, and pass out at the other side.

No. 45 was against the lower plate of **No. 3,** (sandwich cast iron). This round had been looked forward to with great interest, as great things were expected from the chilled cast iron plates, on account of the results already obtained with the smaller guns. The plate, however, was not able to withstand the shock. The projectile was broken into many pieces, which dashed through into what would have been the interior of the ship, carrying with them a great number of ragged fragments of broken plate, and causing such a hail of iron that nothing could have lived between decks. The sand bags behind were deeply pitted with many hundreds of pieces. The experiment proves that the old faults of cast metal still exist—namely that when it breaks under the influence of a heavy blow it is crushed to pieces.

No. 46. Shell broke up in gun; no damage could be discovered.

No. 47 was fired against lower plate of **No. 4,** (combination cast and wrought iron). The target was completely penetrated and ruined, a large portion of the front plate being torn off at the same time. In these two remarkable rounds (45 and 47), not only were the fragments of the cast iron plates driven forward, but also out of the sides of the targets.

After the failure to strike the right spot, recorded in No. 44, on account of the motion, the firing apparatus was transferred to the deck of the pontoon, from which spot in the succeeding fires the gun was

pointed and fired with remarkable accuracy. The projectile striking each time exactly on the spot previously marked on the target.

No. 48 was fired with a reduced charge of powder at **No. 5,** (Brown's 22″ plate). The shell broke up the front part, remaining in the hole, having penetrated 15″.6. Comparing this with No. 43, at **No. 4,** we see that **No. 5,** had much the best of it. The velocities were nearly the same. In 43 the projectile penetrated 31″ of which 19″ were through iron.

No. 49 was fired with 400 lbs of "progressive powder," equal in effects to 341.6 lbs W. A. powder. This is, for the present, the service charge. The aim was at the right of **No. 5.** A large portion of the plate was torn off. The target was completely penetrated, and the rear of it so ruined as to be incapable of repair. The hail of fragments was not so terrible as in the case of the target backed by cast iron.

No. 50 was fired with the small charge of 264 lbs, W. A. powder. The effect was as expected. Aimed at the center of Brown's plate, the projectile just passed through, tearing off a large fragment and splitting it from top to bottom. The backing was not pierced. Brown's plates may be said to have come out No. 1, in the target class.

This terminates the series of tests. The weapon has proved that it can destroy any vessel now afloat. It can therefore be said that the gun is now ahead in the great contests of ordnance *vs.* armor. We now hear rumors of a 200 ton Woolwich gun; we know of a 124 ton Krupp gun being in course of construction; France and Russia are waiting to see this game of bluff well underway before they show their hands, and *we* cannot even put up an anty; perhaps however by not playing, we may save money in the end and at the same time learn the game.

An English firm is ready to furnish 40″ plates to any one who wants to buy them.

I have derived my facts from

The Engineer,
" Engineering,
" London Times,
" " Standard,
U. S. Army and Navy Journal,
Revue de l' Artillerie.